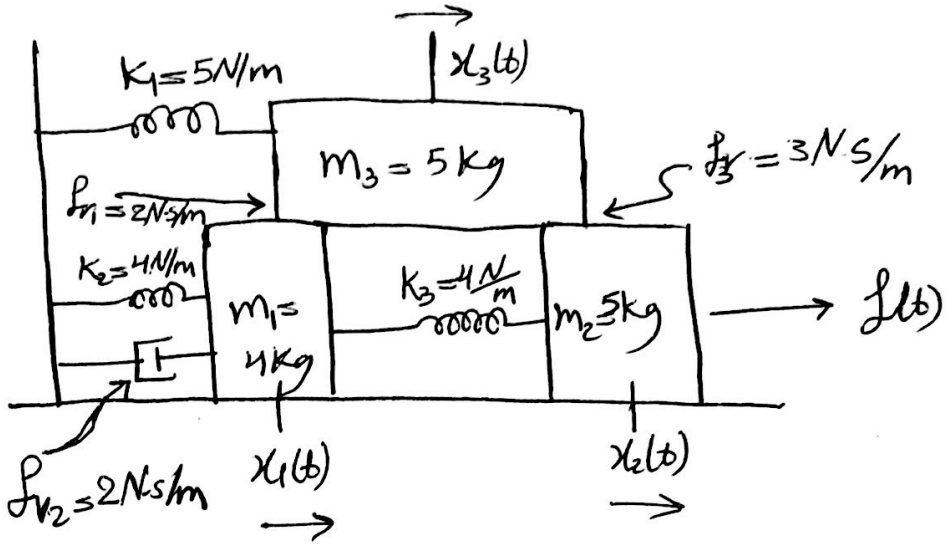
Q Write, but do not solve the equation of motion for the translational system shown in figure below:-



$$m_1 \frac{d^2x_1(t)}{dt^2} + K_2 x_1(t) + f_{r_2} \frac{dx_1(t)}{dt} + f_{r_1}\left(\frac{dx_1(t)}{dt} - \frac{dx_3(t)}{dt}\right) + K_3(x_1(t) - x_2(t)) = \boxed{1}$$

$$m_2 \frac{d^2x_2(t)}{dt^2} + f_{r_3}\left(\frac{dx_2(t)}{dt} - \frac{dx_3(t)}{dt}\right) + K_3(x_2(t) - x_1(t)) = f(t) \longrightarrow \boxed{2}$$

$$m_3 \frac{d^2x_3(t)}{dt^2} + K_1 x_3(t) + f_{r_1}\left(\frac{dx_3(t)}{dt} - \frac{dx_1(t)}{dt}\right) + f_{r_3}\left(\frac{dx_3(t)}{dt} - \frac{dx_2(t)}{dt}\right) = 0 \longrightarrow \boxed{3}$$

We taking the Laplace transform for the three last equations "assuming zero initial conditions"

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For equation [1]

$$4s^2X_1(s) + 4X_1(s) + 2sX_1(s) + 2sX_1(s) - 2sX_3(s) + 4X_1(s) - 4X_2(s) = 0$$

$$\boxed{(4s^2 + 4s + 8)X_1(s) - 4X_2(s) - 2sX_3(s) = 0} \longrightarrow [1]$$

For equation [2]

$$5s^2X_2(s) + 3sX_2(s) - 3sX_3(s) + 4X_2(s) - 4X_1(s) = f(s)$$

$$\boxed{-4X_1(s) + (5s^2 + 3s + 4)X_2(s) - 3sX_3(s) = f(s)} \longrightarrow [2]$$

For equation [3]

$$5s^2X_3(s) + 5X_3(s) + 2sX_3(s) - 2sX_1(s) + 3sX_3(s) - 3sX_2(s) = 0$$

$$\boxed{-2sX_1(s) - 3sX_2(s) + (5s^2 + 5s + 5)X_3(s) = 0} \longrightarrow [3]$$

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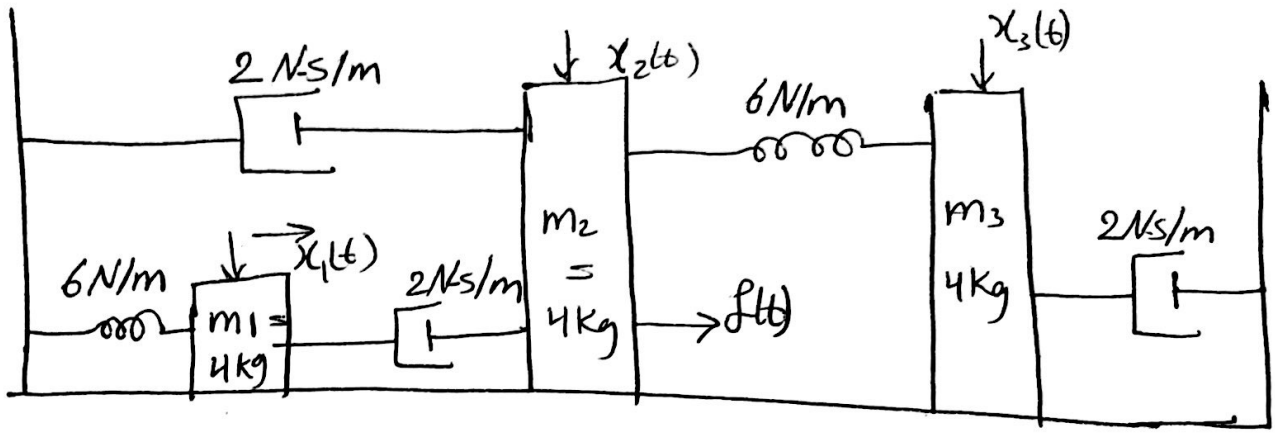
find the T.F $G(s) = \frac{X_3(s)}{F(s)}$, for the translational mechanical system show in figure below



$$4\frac{d^2x_1(t)}{dt^2} + 6x_1(t) + 2\frac{dx_1(t)}{dt} - 2\frac{dx_2(t)}{dt} = 0 \longrightarrow [1]$$

$$4\frac{d^2x_2(t)}{dt^2} + 2\frac{dx_2(t)}{dt} + 2\frac{dx_2(t)}{dt} - 2\frac{dx_1(t)}{dt} + 6x_2(t) - 6x_3(t) = f(t) \longrightarrow [2]$$

$$4\frac{d^2x_3(t)}{dt^2} + 2\frac{dx_3(t)}{dt} + 6x_3(t) - 6x_2(t) = 0 \longrightarrow [3]$$

- We taking the Laplace transform for the three last equations "assuming zero initial conditions"

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for equation [1]

$$4s^2X_1(s) + 6X_1(s) + 2sX_1(s) - 2sX_2(s) = 0$$

$$\boxed{(4s^2+2s+6)X_1(s) - 2sX_2(s) = 0} \longrightarrow [1]$$

for equation [2]

$$4s^2X_2(s) + 2sX_2(s) + 2sX_2(s) - 2sX_1(s) + 6X_2(s) - 6X_3(s) = F(s)$$

$$\boxed{(4s^2+4s+6)X_2(s) - 2sX_1(s) - 6X_3(s) = F(s)} \longrightarrow [2]$$

for equation [3]

$$4s^2X_3(s) + 2s^1X_3(s) + 6X_3(s) - 6X_2(s) = 0$$

$$\boxed{(4s^2+2s+6)X_3(s) - 6X_2(s) = 0} \longrightarrow [3]$$

$$X_3(s) = \frac{\Delta_3}{\Delta} = \frac{\begin{vmatrix} 4s^2+2s+6 & -2s & 0 \\ -2s & 4s^2+4s+6 & F(s) \\ 0 & -6 & 0 \end{vmatrix}}{\begin{vmatrix} (4s^2+2s+6) & -2s & 0 \\ -2s & (4s^2+4s+6) & -6 \\ 0 & -6 & (4s^2+4s+6) \end{vmatrix}} = \frac{3F(s)}{s(8s^3+12s^2+26s+18)}$$

$$\text{T.F } \frac{X_3(s)}{F(s)} = \frac{3}{s(8s^3+12s^2+26s+18)} \quad //$$

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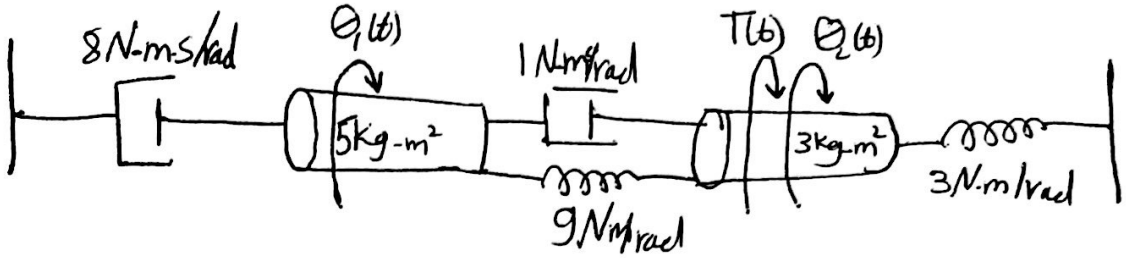
write, but do not solve, the equations of motion for the rotational mechanical system.



$$5\frac{d^2\theta_1(t)}{dt} + 8\frac{d\theta_1(t)}{dt} + 1\frac{d\theta_1(t)}{dt} - 1\frac{d\theta_2(t)}{dt} + 9\theta_1(t) - 9\theta_2(t) = 0 \rightarrow [1]$$

$$3\frac{d^2\theta_2(t)}{dt} + 3\theta_2(t) + 1\frac{d\theta_2(t)}{dt} - 1\frac{d\theta_1(t)}{dt} + 9\theta_2(t) - 9\theta_1(t) = T(t) \rightarrow [2]$$

By taking the Laplace transform

we get

$$5s^2\theta_1(s) + 8s\theta_1(s) + s\theta_1(s) - s\theta_2(s) + 9\theta_1(s) - 9\theta_2(s) = 0$$

$$\boxed{(5s^2 + 9s + 9)\theta_1(s) - (s + 9)\theta_2(s) = 0} \rightarrow [1]$$

$$3s^2\theta_2(s) + 3\theta_2(s) + s\theta_2(s) - s\theta_1(s) + 9\theta_2(s) - 9\theta_1(s) = T(s)$$

$$\boxed{-(s+9)\theta_1(s) + (3s^2 + s + 12)\theta_2(s) = T(s)} \rightarrow [2]$$

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